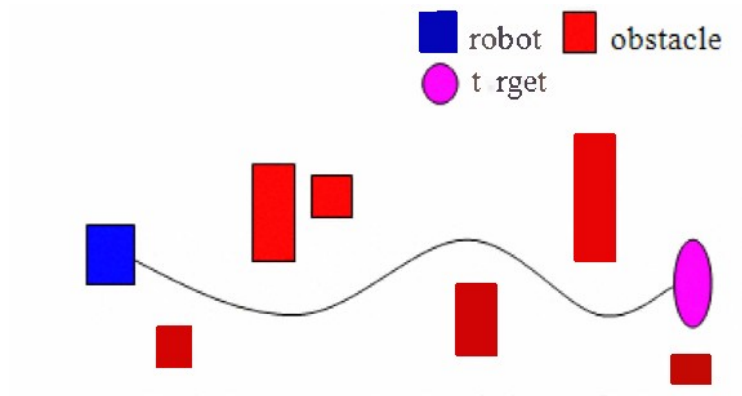


Path following for mobile robots

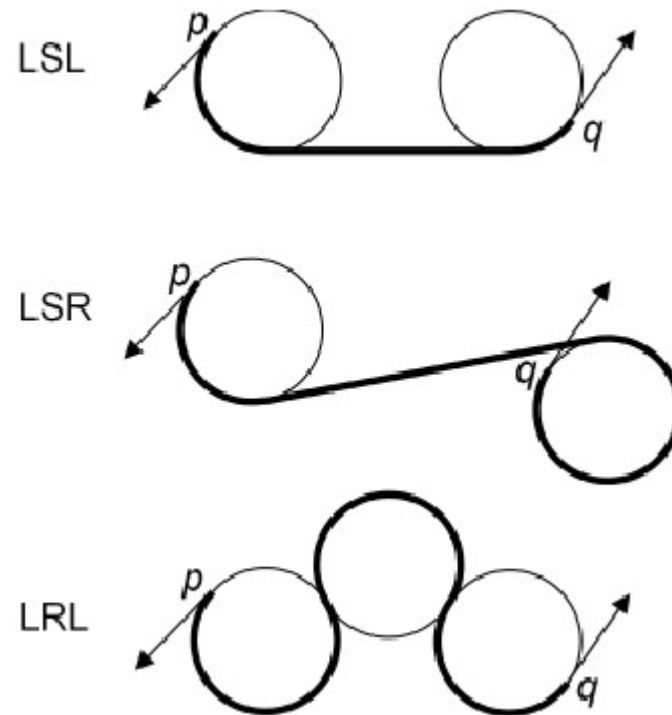
Guiding Vector Fields (GVF)

Given a desired path, how does a robot follow it?



Following straight lines and circles

Dubin's path consists of a sequence of lines and circles



Implicit equations of the path

Circle $\rightarrow f(x,y) := (x-x_c)^2 + (y-y_c)^2 - r^2 = 0$

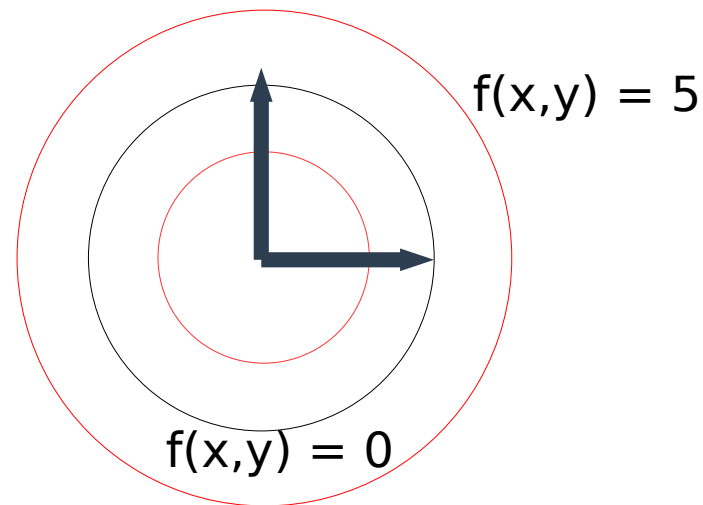
Straight line $\rightarrow f(x,y) := ax + by + c = 0$

Level sets

$$x^2 + y^2 - r^2 = 5 \quad \text{Outer}$$

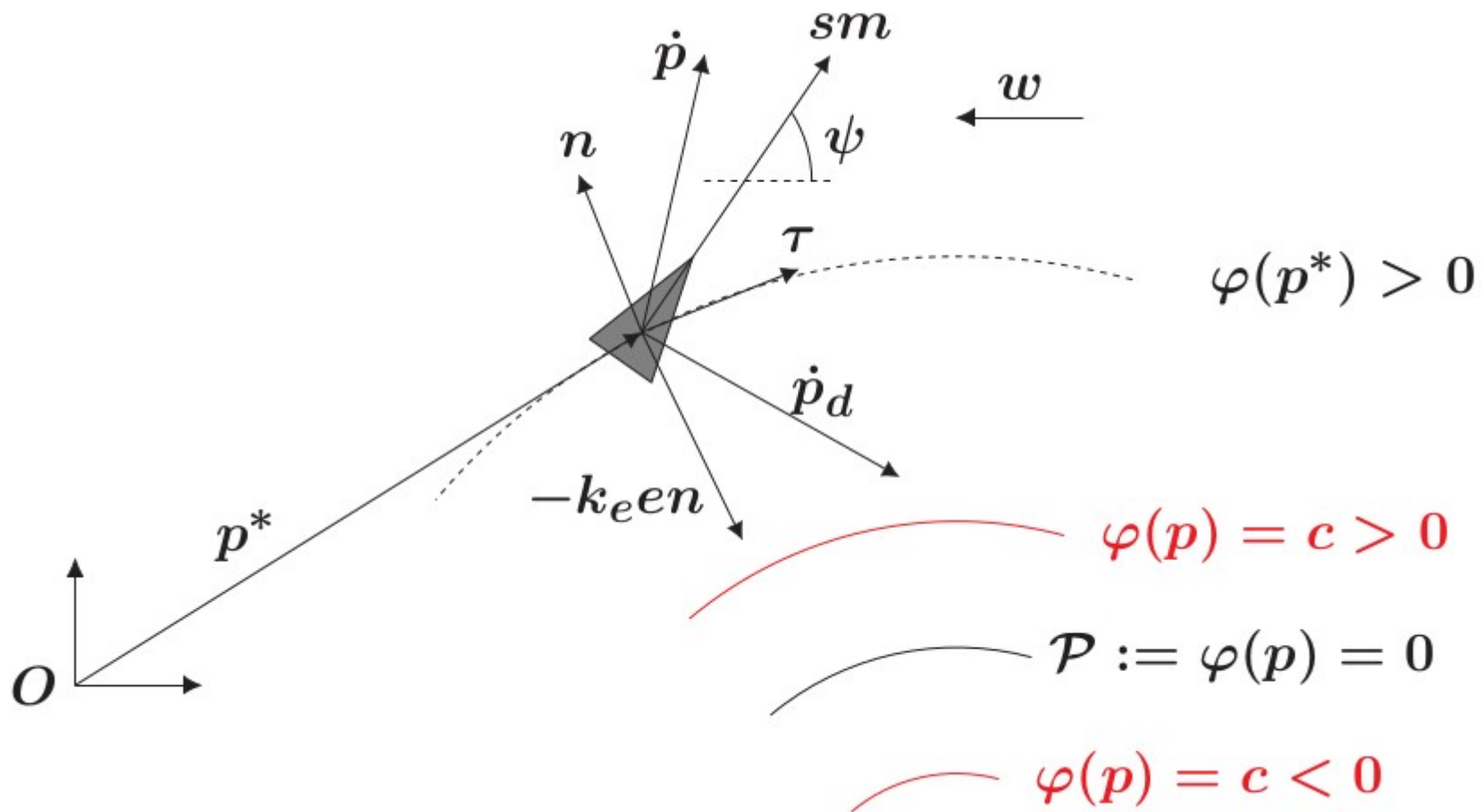
$$x^2 + y^2 - r^2 = 0 \quad \text{Target trajectory}$$

$$x^2 + y^2 - r^2 = -5 \quad \text{Inner}$$



$f(x,y)$ can be used as an error signal!

How to follow the desired trajectory? We need the normal and tangent vectors



We need the Jacobian of the path

Circle $\rightarrow f(x,y) := (x-x_c)^2 + (y-y_c)^2 - r^2 = 0$

Straight line $\rightarrow f(x,y) := ax + by + c = 0$

The Jacobian tells us in which direction the level set grows! (normal to the path)

Jacobian of the circle

Jac = $2[(x-x_c) (y-y_c)]$ is the normal vector to the circle

Jacobian of the straight line

Jac = $[a \ b]$ is the normal vector to the line

We need the tangent to the path

It is just the 90 degrees rotation of the Jacobian

$$\text{Tangent} = \text{Rot}(90) \text{ Jac}$$

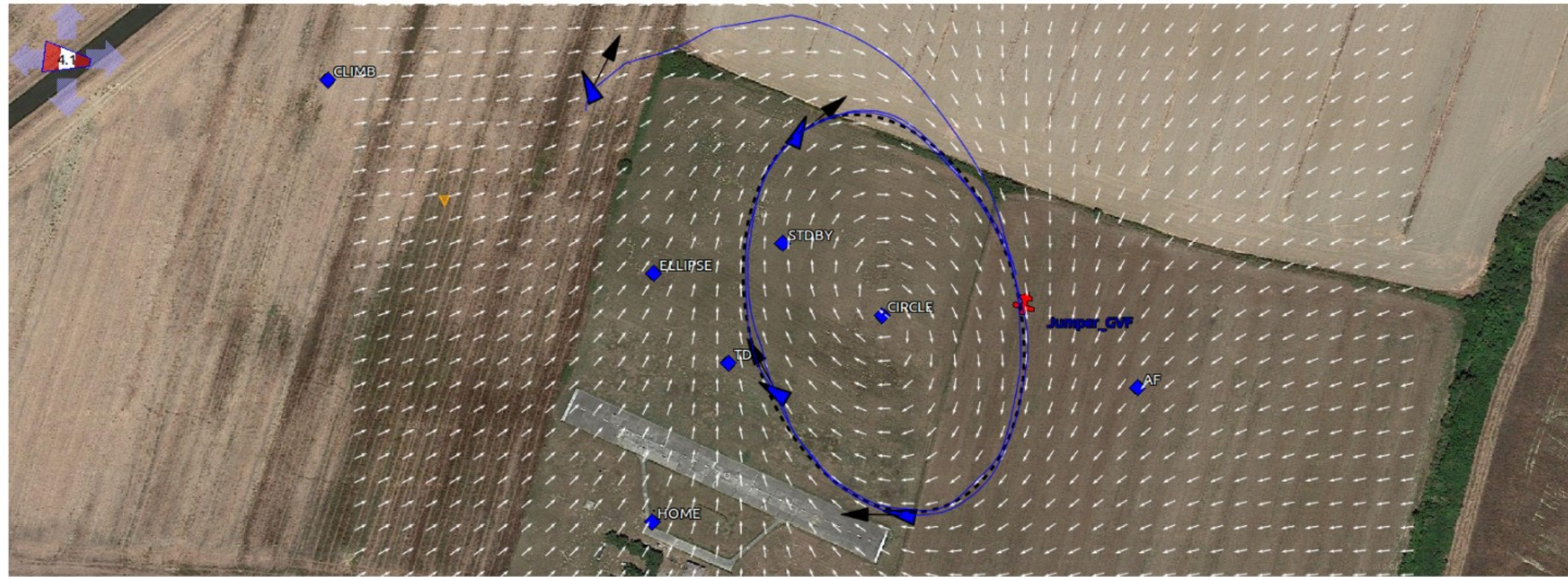
The direction to follow is the combination of the normal and tangent

Control action or direction to follow

$e:=f(x,y)$ (error signal)

Direction to follow = tangent - e *normal

Example with an ellipse



Jumper_GVF
00:13:36 10.9m/s 38% ellipse1 Nav

Bat	Status	AGL	Block
10.9	AUTO2	78	Time 01:51
	OK	+0.7	Stage 01:51
			ETA N/A

Link 3D /Target Alt
-2m 272m / 274m

Nav icons: Home, Stop, Refresh, Up, Down, Left, Right, Mark

Jumper_GVF

Flight Plan	GPS	PFD	Link	Misc
▶ block				Holding point
▶ block				Takeoff
▶ block				Standby
▶ block				circle
▶ block				ellipse1
▶ block				ellipse2
▶ block				Land Right AF-TD
▶ block				Land Left AF-TD

14:08:56 Waiting for tele
14:08:57 Not_found
14:08:57 Jumper_GVF, el
14:08:57 Jumper_GVF, A
14:08:57 Jumper_GVF, li
14:08:57 Jumper_GVF, al
14:18:02 Jumper_GVF, el
14:18:02 Jumper_GVF, li
14:18:07 Jumper_GVF, al
14:20:08 Jumper_GVF, li
14:20:14 Jumper_GVF, al
14:20:41 Jumper_GVF, li
14:20:47 Jumper_GVF, al